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Introduction to Unix

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Tutorial adopted from “Unix For Beginners”
by Michael Stonebank
http://www.ee.surrey.ac.uk/Teaching/Unix/

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Introduction to the UNIX Operating System

- What is UNIX?
- Files and processes
- The Directory Structure
- Starting an UNIX terminal
- Working with UNIX commands

What is UNIX?

- An operating system developed in 1969 – began it's life

- Under continuous developments since then

What is Unix

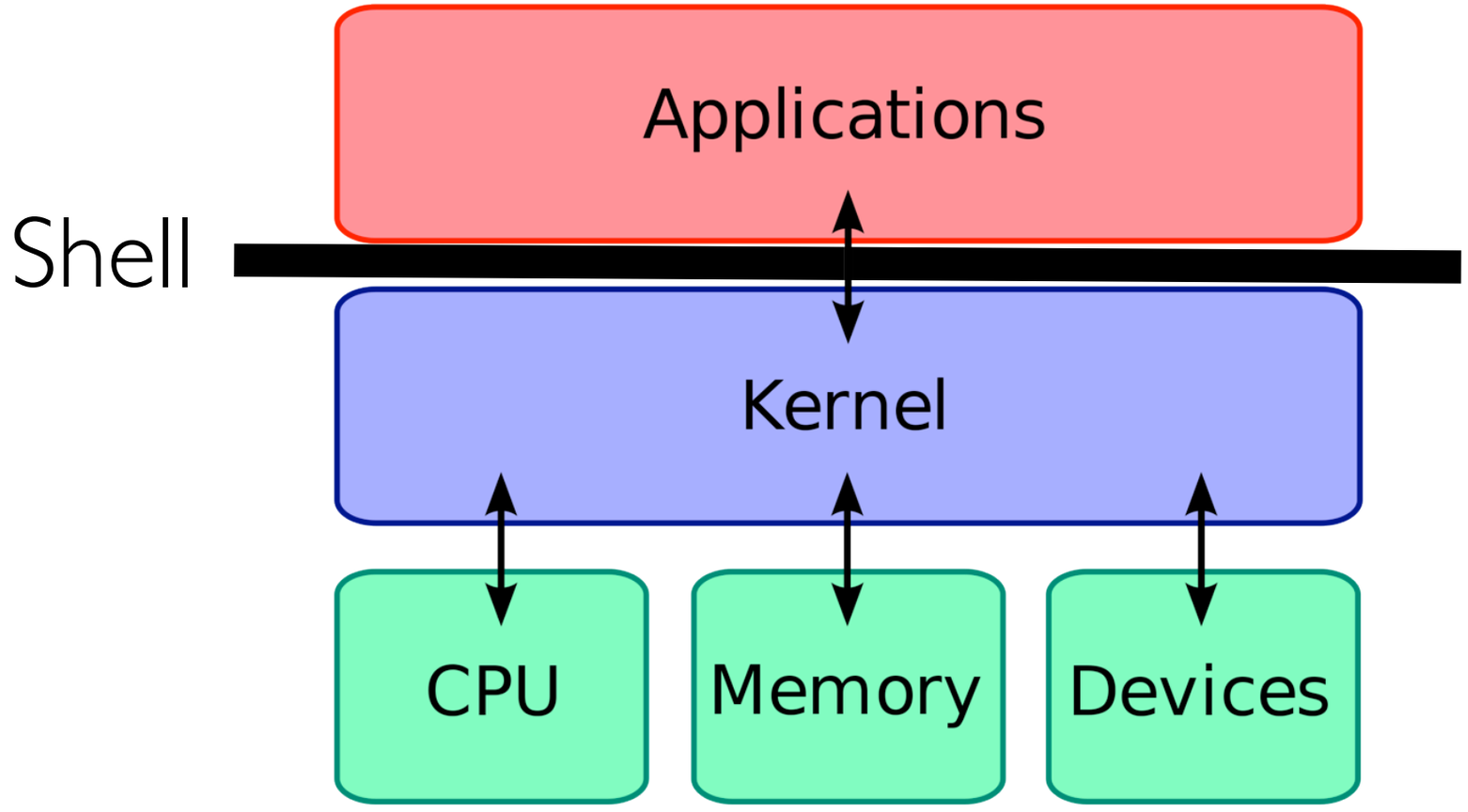
- Graphical user interface (GUI) is available, but knowledge of the the UNIX user environment is required to carry out operations not covered by a GUI.
- secure shell (ssh) session.

Types of UNIX

- There are many different versions of UNIX, although they share basic similarities.
  - Sun Solaris,
  - GNU/Linux,
  - MacOS X (Darwin).
- We use GNU/Linux or IRIX® on our servers.

The UNIX operating system

The UNIX operating system is made up of three parts; the kernel, the shell and the programs (applications).



The shell

- Interface between user and kernel.
- Example of shell's work:

  When you login, following happens:

  1. check username and password
  2. If successful, start shell (also a commandline interpreter)
  3. For example, remove a file "deleteme"

     rm deleteme
  4. Shell interprets and passes the command to the operating system
  5. The file gets removed

The Shell - 2

Shell is customizable

Shell can complete your commands/file name when you press [TAB].

Command History

- The shell keeps a list of the commands you have typed in.
- If you need to repeat a command, use the cursor keys to scroll up and down the list or type history for a list of previous commands.

Files and processes

Everything in UNIX is either a file or a process, even a computer display.

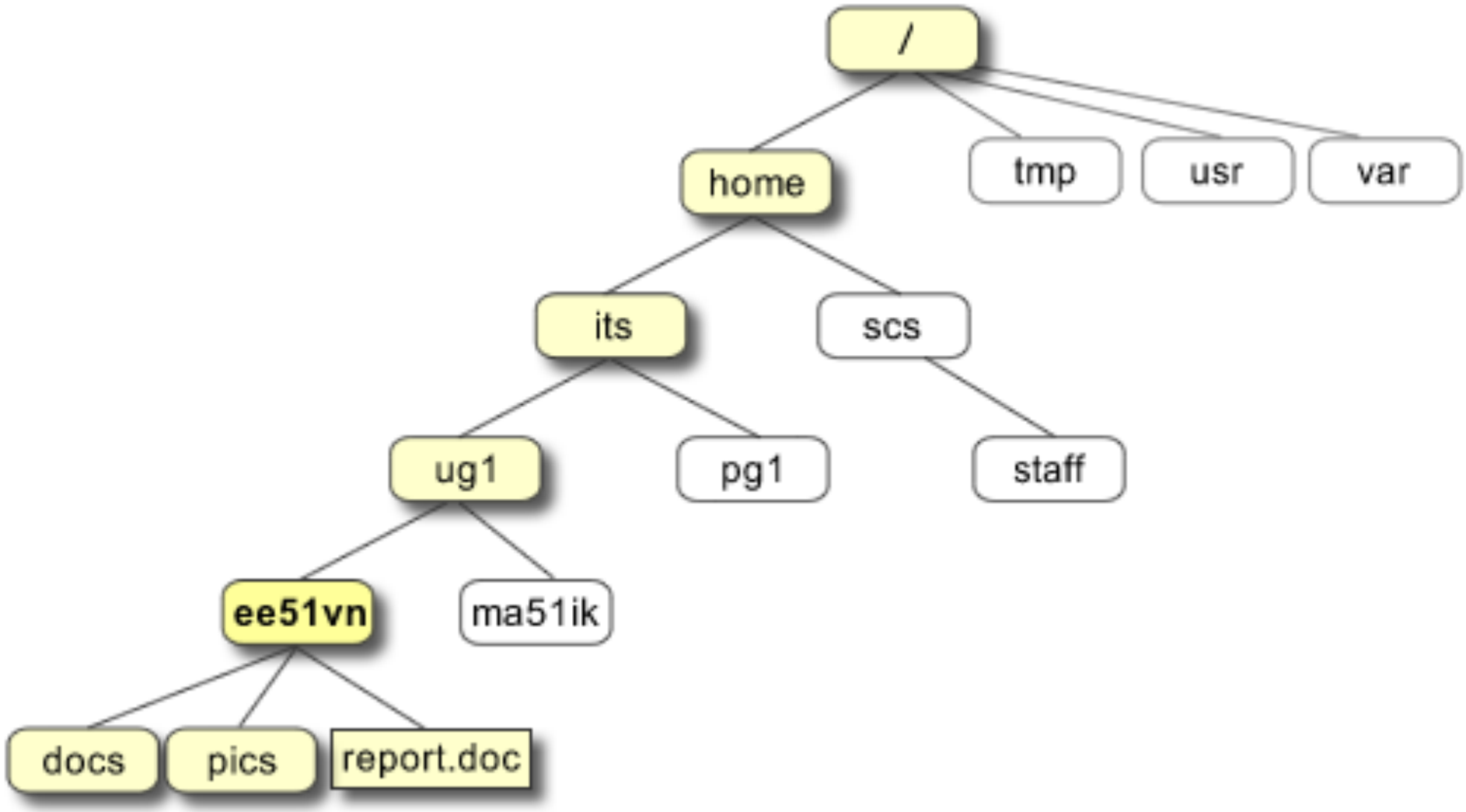
- A process is an executing program identified by a unique PID (process identifier).
- A file is a collection of data. They are created by users using text editors, running compilers etc.

Examples of files:

- a document (report, essay etc.)
- the text of a program written in some high-level programming language
- instructions comprehensible directly to the machine and incomprehensible to a casual user, for example, a collection of binary digits (an executable or binary file);
- a directory, containing information about its contents, which may be a mixture of other directories (subdirectories) and ordinary files.

Enough of the theory, let's get some hands on

UNIX directory structure



All the files are grouped together in the directory structure. The file-system is arranged in a hierarchical structure, like an inverted tree. The top of the hierarchy is traditionally called **root** (written as a slash /)

Listing files and directories

Command ls lists the contents of your current working directory.

> ls ; shows a listing of files and directories

> ls –a ; also shows hidden files

> ls -l ; detailed listing of files and directories

> ls –lt ; time sorted listing

> ls –lsh ; detailed listing, with "human-readable" file sizes (GB, MB, KB, etc).

> ls –l pathname ; gives listing for a given directory

> ls –l filename : gives details on a specific file

More options available. Look for the help page.

> man ls

Making Directories

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mkdir (make directory)

We will now make a subdirectory in your home directory to hold the files you will be creating and using in the course of this tutorial. To make a subdirectory called unixstuff in your current working directory type

```
> mkdir unixstuff
```

To see the directory you have just created, type

```
> ls
```

Changing Directories

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cd (change directory)

The command cd directory means change the current working directory to '*directory*'. The current working directory may be thought of as the directory you are in, i.e. your current position in the file-system tree.

To change to the directory you have just made, type

> cd unixstuff

Type ls to see the contents (which should be empty)

Exercise

Make another directory inside the **unixstuff** directory called **backups**

Still in the **unixstuff** directory, type

> ls -a

As you can see, in the **unixstuff** directory (and in all other directories), there are two special directories called (.) and (..)

. and ..

The current directory (.)

In UNIX, (.) means the current directory, so typing

```
> cd .
```

NOTE: there is a space between cd and the dot

means stay where you are (the **unixstuff** directory).

This may not seem very useful at first, but using (.) as the name of the current directory will save a lot of typing, as we shall see later in the tutorial.

The parent directory (..)

(..) means the parent of the current directory, so typing

```
> cd ..
```

will take you one directory up the hierarchy (back to your home directory). Try it now.

Note: typing cd with no argument always returns you to your home directory. This is very useful if you are lost in the file system.

Pathnames

pwd (print working directory)

Pathnames enable you to work out where you are in relation to the whole file-system. For example, to find out the absolute pathname of your home-directory, type cd to get back to your home-directory and then type

```
> pwd
```

The full pathname will look something like this -

/home/people/stud110

which means that **stud110** (your home directory) is in the sub-directory **people** (the group directory), which in turn is in the **home** sub-directory, which is in the top-level root directory called " / " .

More about home directories and pathnames

Understanding pathnames

First type cd to get back to your home-directory, then type

> ls unixstuff

to list the contents of your unixstuff directory.

Now type

> ls backups

You will get a message like this -

backups: No such file or directory

The reason is, **backups** is not in your current working directory. To use a command on a file (or directory) not in the current working directory (the directory you are currently in), you must either cd to the correct directory, or specify its full pathname. To list the contents of your backups directory, you must type

> ls unixstuff/backups

~ (your home directory)

Home directories can also be referred to by the tilde ~ character. It can be used to specify paths starting at your home directory. So typing

```
> ls ~/unixstuff
```

will list the contents of your unixstuff directory, no matter where you currently are in the file system.

What do you think

```
> ls ~
```

would list?

What do you think

```
> ls ~/..
```

would list?

Summary

`ls` : list files and directories
`ls -a` : list all files and directories
`mkdir` : make a directory
`cd <directory>` : change to named <directory>
`cd` : change to home-directory
`cd ~` : change to home-directory
`cd ..` : change to parent directory
`Pwd` : display the path of the current directory

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Copying Files

cp (copy) file1 file2

First, cd to your **unixstuff** directory.

> cd ~/unixstuff

Then at the UNIX prompt, type,

> cp /home/people/tejal/public_html/courses/Random_text.txt .

Note: Don't forget the dot **.** at the end. Remember, in UNIX, the dot means the current directory.

The above command means copy the file **Random_text.txt** to the current directory, keeping the name the same.

Exercise

Create a backup of your Random_text.txt file by copying it to a file called **Random_text.bak**

Moving files

mv (move)

mv file1 file2 moves (or renames) **file1** to **file2**

To move a file from one place to another, use the mv command. This has the effect of moving rather than copying the file, so you end up with only one file rather than two.

It can also be used to rename a file, by moving the file to the same directory, but giving it a different name.

We are now going to move the file Random_text.bak to your backup directory.

First, change directories to your unixstuff directory (can you remember how?). Then, inside the **unixstuff** directory, type

> mv Radom_text.bak backups

Type ls and ls backups to see if it has worked.

Removing files and directories

rm (remove), rmdir (remove directory)

To delete (remove) a file, use the `rm` command. As an example, we are going to create a copy of the **Random_text.txt** file then delete it.

Inside your **unixstuff** directory, type

```
> cp Random_text.txt tempfile.txt
> ls
> rm tempfile.txt
> ls
```

You can use the `rmdir` command to remove a directory (make sure it is empty first). Try to remove the **backups** directory. You will not be able to since UNIX will not let you remove a non-empty directory.

Exercise

Create a directory called **tempstuff** using `mkdir` , then remove it using the `rmdir` command.

Displaying the contents of a file on the screen

clear (clear screen)

Before you start the next section, you may like to clear the terminal window of the previous commands so the output of the following commands can be clearly understood.

At the prompt, type

```
> clear
```

This will clear all text and leave you with the prompt at the top of the window.

cat (concatenate)

The command cat can be used to display the contents of a file on the screen. Type:

```
> cat Random_text.txt
```

As you can see, the file is longer than than the size of the window, so it scrolls past making it unreadable.

less to view file contets

less

The command less writes the contents of a file onto the screen a page at a time. Type

> less Random_text.txt

Press the [**space-bar**] if you want to see another page, and type [**q**] if you want to quit reading. As you can see, less is used in preference to cat for long files.

head

The head command writes the first ten lines of a file to the screen.

First clear the screen then type

```
> head Random_text.txt
```

Then type

```
> head –n 5 Random_text.txt
```

What difference did the –n 5 do to the head command?

tail

The tail command writes the last ten lines of a file to the screen.

Clear the screen and type

```
> tail Random_text.txt
```

Q. How can you view the last 2 lines of the file?

Searching the contents of a file

Simple searching using less

Using less, you can search though a text file for a keyword (pattern). For example, to search through **Random_text.txt** for the word **"HGNC'**, type

> less Random_text.txt

then, still in less, type a forward slash [/] followed by the word to search

/ENSG00000061273

As you can see, less finds and highlights the keyword. Type [**n**] to search for the next occurrence of the word.

Wildcard characters in file names

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- What if you do not know the file name ?
  - for example, find files with “txt” extension

    > ls *.txt
  - find files with 5 letter names starting with “gene” and extension .fa

    > ls gene?.fa

You can use wildcard characters with nearly all Unix commands, as long as they are not ambiguous or risky.

Summary on wildcards

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* matches any number of characters in a filename, including none.

? matches any single character.

[ ] Enclose a set of characters, any one of which may match a single character at that position.

- Used within [ ] to denote a range of characters. E.g. [A-Z], [a-b], [1-6], etc.

Wildcard characters

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- To copy all files from */home/people/tejal/public_html/courses* to your home directory.

> *cp –R* /home/people/tejal/public_html/courses/* .

Exercise:

Find fasta files (.fa) starting with *pou*, have atleast 5 characters (including *pou)*.

Grep, pattern search tool

grep *pattern* filename

`grep` is one of many standard UNIX utilities. It searches files for specified words or patterns. First clear the screen, then type

```
> grep hgnc Random_text.txt
```

As you can see, `grep` has printed out each line containg the word **hgnc**.

Or has it ????

Try typing

```
> grep -i hgnc Random_text.txt
```

`grep` command is case sensitive; it distinguishes between hgnc and HGNC. Use *i* to ignore case.

Grep cont.

To search for a phrase or pattern, you must enclose it in single quotes (the apostrophe symbol). For example to search for spinning top, type

```
> grep -i 'hgnc' Random_text.txt
```

Some of the other options of grep are:

-v display those lines that do NOT match
-n precede each matching line with the line number
-c print only the total count of matched lines

Try some of them and see the different results. Don't forget, you can use more than one option at a time. For example, the number of lines without the words hgnc or HGNC is

```
> grep -ivc hgnc Random_text.txt
```

Complex patterns can be shown as regular expressions

REGULAR EXPRESSIONS

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Regular Expressions

- There are three operators used to build regular expressions. Let R and S be regular expressions and L(R) the set of strings that match R.

- Union
  - R|S $L(R|S) = L(R) \cup L(S)$
- Concatenation
  - RS $L(RS) = \{rs, r \in R \text{ and } s \in S\}$
- Closure
  - R* $L(R^*) = \{\varepsilon, R, RR, RRR, \ldots\}$

Regular Expressions

- a|(ab)
- a
- a*b*
- (ab)*
- a|bc*d
- letter = a|b|c|…|z|A|B|C|…|Z|_
- digit = 0|1|2|3|4|5|6|7|8|9
- letter(letter|digit)*

Regular Expressions

^ beginning of line
$ end of line
. any single character
[…] any one of the characters in … ; E.g. [A-Z]
[^…] any single character not in …; ranges are legal.
\n what the nth character \(…\) matched (grep only)
r* zero or more occurrences of regular expression r
r+ one or more occurrences of regular expression r
r1r2 regular expressions r1 followed by r2
^$ Empty lines
[[:space:]] Any space characters (white space, tab, etc.)
[[:alnum:]] Any alphanumeric (0-9 or A-Z)

wc – word count and more

A handy little utility is the wc command, short for word count. To do a word count on **Random_text.txt**, type

```
> wc -w Random_text.txt
```

To find out how many lines the file has, type

```
> wc -l Random_text.txt
```

Regular expression

- Use of regular expression is wide-spread.
- UNIX grep (grep –E), egrep and awk use regular expression.
- Perl and Python uses them too.

Practice more

- *grep –E* or *egrep* can be used with regular expressions.

- *grep –f patternfile file* will search list of patterns in the *patternfile* in *file*.

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Working with Files

- Redirection
- Redirecting the Output
- Redirecting the Input
- Pipes

Redirection

- UNIX commands mostly write output to standard out (screen).
- Most commands take input from standard input (keyboard)
- Cat command without filename :

> cat

Then type a few words on the keyboard and press the [**Return**] key.

Finally hold the [**Ctrl**] key down and press [**d**] (written as **^D** for short) to end the input.

What has happened?

In UNIX, we can redirect both the input and the output of commands.

Redirecting the Output

We use the > symbol to redirect the output of a command. For example, to create a file called **list1** containing a list of fruit, type

```
> cat > list1
```

Then type in the names of some fruit. Press [**Return**] after each one.

```
pear
banana
apple
^D {this means press [Ctrl] and [d] to stop}
```

What happens is the cat command reads the standard input (the keyboard) and the > redirects the output, which normally goes to the screen, into a file called **list1**

To read the contents of the file, type

```
> cat list1
```

Exercise

Using the above method, create another file called **list2** containing the following fruit: orange, plum, mango, grapefruit. Read the contents of **list2**

Appending to a file

The form >> appends standard output to a file. So to add more items to the file **list1**, type

```
> cat >> list1
```

Then type in the names of more fruit

```
peach
grape
orange
^D (Control D to stop)
```

To read the contents of the file, type

```
> cat list1
```

You should now have two files. One contains six fruit, the other contains four fruit.

We will now use the cat command to join (concatenate) **list1** and **list2** into a new file called **biglist**. Type

```
> cat list1  list2 > biglist
```

What this is doing is reading the contents of **list1** and **list2** in turn, then outputing the text to the file **biglist**

To read the contents of the new file, type

```
> cat biglist
```

Redirecting the input

We use the < symbol to redirect the input of a command.

Using < you can redirect the input from a and the keyboard. For example, to sort the list of fruit, type

```
> sort < biglist
```

and the sorted list will be output to the screen.

To output the sorted list to a file, type,

```
> sort < biglist > slist
```

Use cat to read the contents of the file **slist**

Pipes

To see who is on the system with you, type

```
> who
```

One method to get a sorted list of names is to type,

```
> who > names.txt
> sort < names.txt
```

This is a bit slow and you have to remember to remove the temporary file called *names* when you have finished.

Can this be done without creating a temporary file ?

Yes, use *pipe* (symbol "|") [Vertical bar]

```
> who | sort
```

will give the same result as above, but quicker and cleaner.

To find out how many users are logged on, type

```
> who | wc -l
```

Exercise

Using pipes, display all lines of **list1** and **list2** containing the letter 'p', and sort the result.

Answer

```
> cat list1 list2 | grep p | sort
```

Summary

Command	Meaning
command > file	redirect standard output to a file
command >> file	append standard output to a file
command < file	redirect standard input from a file
command1 | command2	pipe the output of command1 to the input of command2
cat *file1 file2 > file0*	concatenate file1 and file2 to file0
sort	sort data
who	list users currently logged in

Data manipulation

- Replace a character to another character
- for example,

➢ cat Random_text.txt | tr ‘c’ ‘d’ ; will translate “c” into “d”

tr takes input from the standard out only.

Data manipulation

- suppress multiple occurrences of a character, for example a white space

```
> cat Random_text.txt | tr –s “ “
```

Finding a specific column of a file

- *cut –f fieldnumbers –d delimiter filename*

➢cut –f 1 –d ";" evalSet

will print first column of evalSet file, columns are delimited by ";".

cut –f 1-2 –d ";" evalSet

will print find a range of columns separated by ";"

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